EXPERIMENT-2

COMMON COLLECTER AMPLIFIER

AIM: To design a Single stage CC amplifier with following specifications, calculate voltage gain and input resistance.

OBJECTIVES:

1. Design a common collector amplifier for given specifications.
2. Simulate the designed amplifier.
3. Develop the hardware for designed amplifier.
4. Compare simulated results with practical results.

APPARATUS:

S.No.	Name of the Component/ Equipment	Specifications	Quantity
1.	Transistor (BC-107)	B=100	1
2.	Capacitors (designed values)	Voltage rating= 1.6V	3
3	Resistors (designed values)	Power Rating =0.5 W	4
4	Function Generator	(0 -1) MHZ	1
5	Cathode Ray Oscilloscope	20 MHZ	1
6	Regulated Power Supply	(0-30) V,1Amp	1

THEORY:

A common collector (CC) amplifier, also known as an emitter follower, is one of the three basic transistor amplifier configurations, the other two being common base (CB) and common emitter (CE) amplifiers. CC amplifiers have specific characteristics and applications, and there are various theories and principles associated with their operation. Here's a brief overview of the theory behind CC amplifiers: Configuration: A CC amplifier uses an NPN transistor or PNP transistor (depending on the desired polarity) with the emitter connected to the input, the collector connected to the output, and the base connected to the input through a biasing resistor.

Voltage Gain: CC amplifiers have a voltage gain of approximately 1. This means that the output voltage follows the input voltage with a slight voltage drop due to the transistor's characteristics. The primary purpose of a CC amplifier is not voltage gain but to provide current gain and impedance matching. Current Gain: CC amplifiers provide a high current gain, which means that they can source or sink a substantial amount of current. This is useful in applications where a low-output impedance is required to drive a load.

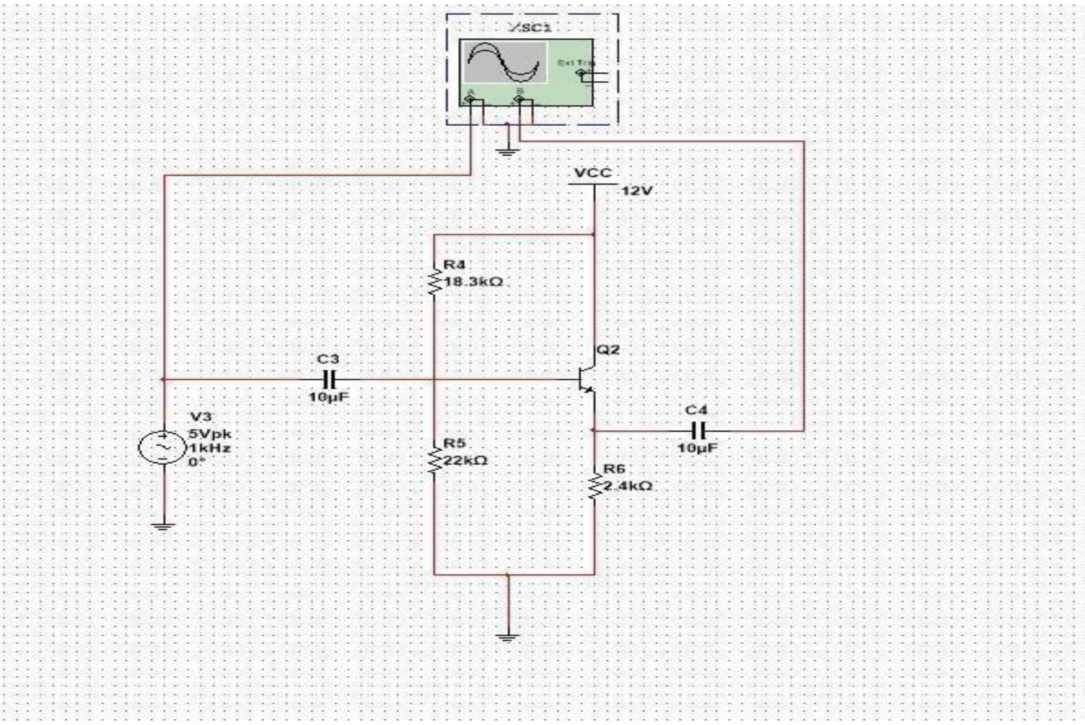
Input and Output Impedance: The input impedance of a CC amplifier is relatively high, making it suitable for applications where the input signal source has a high impedance. The output impedance of a CC amplifier is low, which allows it to drive lowimpedance loads effectively.

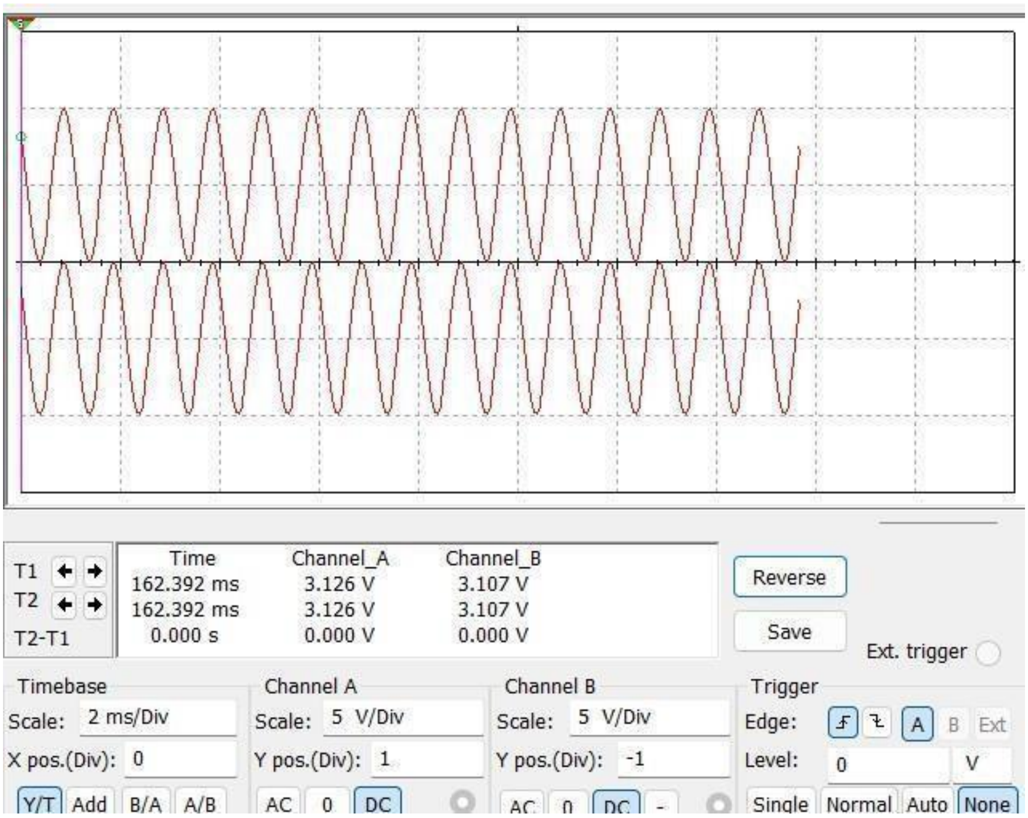
Phase Relationship: The output of a CC amplifier is in-phase with the input signal. This makes it useful for impedance matching between different stages of an electronic circuit. Biasing: Proper biasing of the transistor is crucial to ensure the CC amplifier operates in the desired region, typically in the active region. This involves setting the base current and collector current to appropriate values.

Applications: CC amplifiers are commonly used as buffer amplifiers to isolate one part of a circuit from another, to provide impedance matching, and to drive low-impedance loads such as speakers. Feedback: CC amplifiers can be used as the output stage in amplifier circuits, and they are often found in audio power amplifier designs when combined with feedback to improve linearity and reduce distortion.

In summary, the common collector (CC) amplifier is a transistor amplifier configuration that offers current gain, impedance matching, and a high-frequency response. Its primary function is not voltage amplification, but it is valuable in various electronic applications where current gain and impedance characteristics are essential. Proper biasing and component selection are critical for its successful operation.

DESIGN OF CC AMPLIFIER:





Conclusion:

For the designed circuit the gain is approximately 1 for which the amplification does not occur

Procedure:

1. Switch ON the computer and open the Multisim software
2. Observe Design tool box, Instrumentation tool box, component tool box and its component functionality
3. From above tool boxes, Connect the circuit using the designed values of each and every component
4. Connect the function generator with sine wave of 20 mV p-p as input at the input terminals of the circuit. (Or) use signal source.
5. Connect the Cathode Ray Oscilloscope (CRO) to the output terminals of the circuit.
6. Go to simulation button click it for simulation process.
7. From the CRO note the following values1.

• Input voltage V in, Output voltage V out, Voltage Gain Av.

Design Calculations:

Given Data:

- Ic = 2.5mA
- β=100
- Vcc = 12V

<u>Calculation of Re:</u>

QPoint(V_{ce}, I_c) = (6V,2.5mA)

Re = V_{ce}/ I_c = 6V/2.5mA = 2.4kΩ

$\boxed{Re = 2.4k\Omega}$

<u>Calculation of R1&R2:</u>

Voltage acting at base = (6+0.7)V

By appling Voltage division,

R2/(R1+R2)*12 = 6.7

R1 = 0.8R2

We know that,

$R2 << \beta * 2.4k\Omega$

$R2 << 100 * 2.4k\Omega$

$R2 < 10 * 2.4k\Omega$

$R2 < 24k\Omega$

$\boxed{R2 = 22k\Omega}$

$R1 = R1 = 0.8R2 = 0.8 * 22k\Omega$

$\boxed{R1 = 18.3k\Omega}$

Calculation of Rs:

$Rs = R1||R2$

$= (R1*R2)/(R1+R2)$

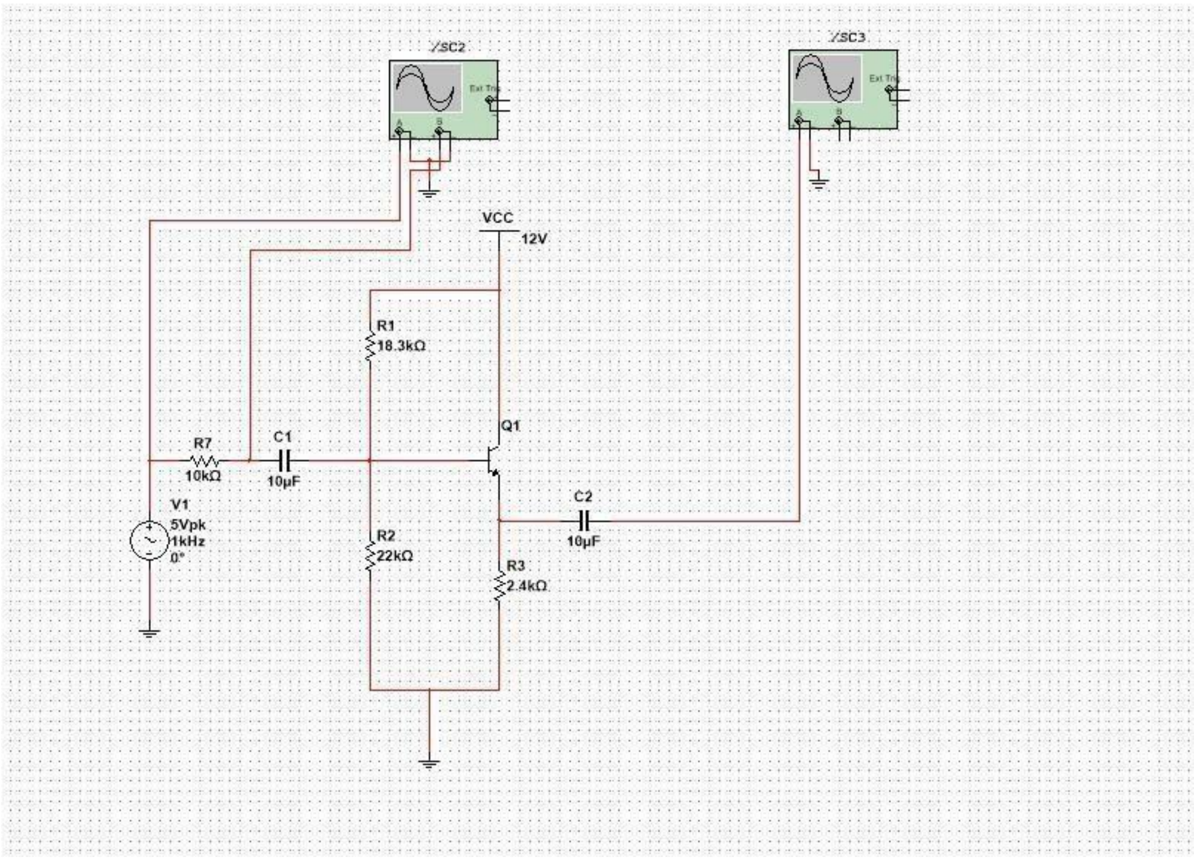
$= (18.3k\Omega * 22k\Omega)/(18.3k\Omega + 22k\Omega)$

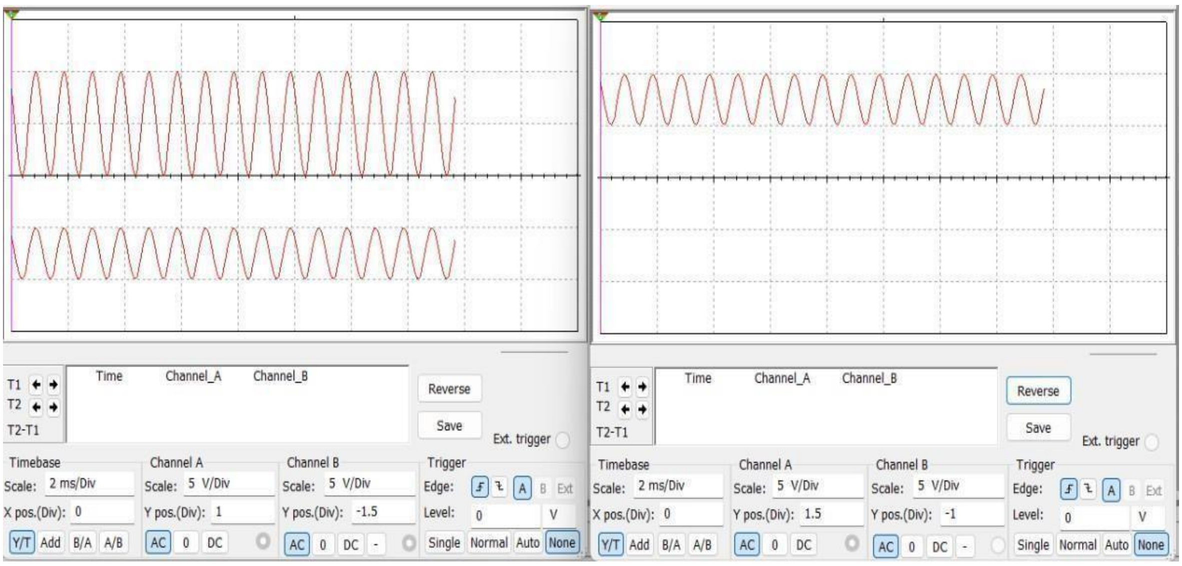
$= 9.9\ k\Omega = 10\ k\Omega$ (approx.)

$\boxed{Rs = 10K\Omega}$

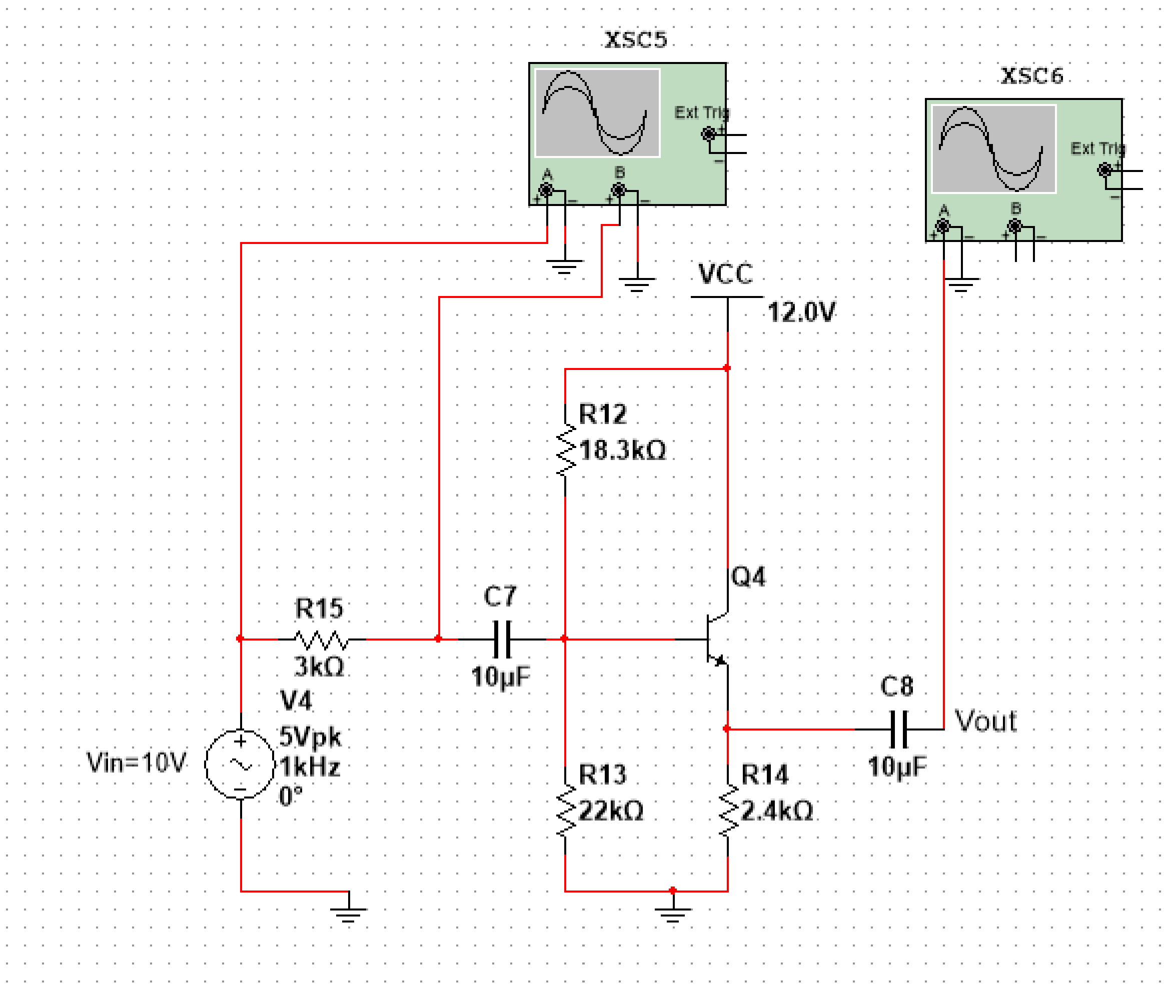
Calculation of input series resistance for CC amplifier through maximumpower transfer theorem:

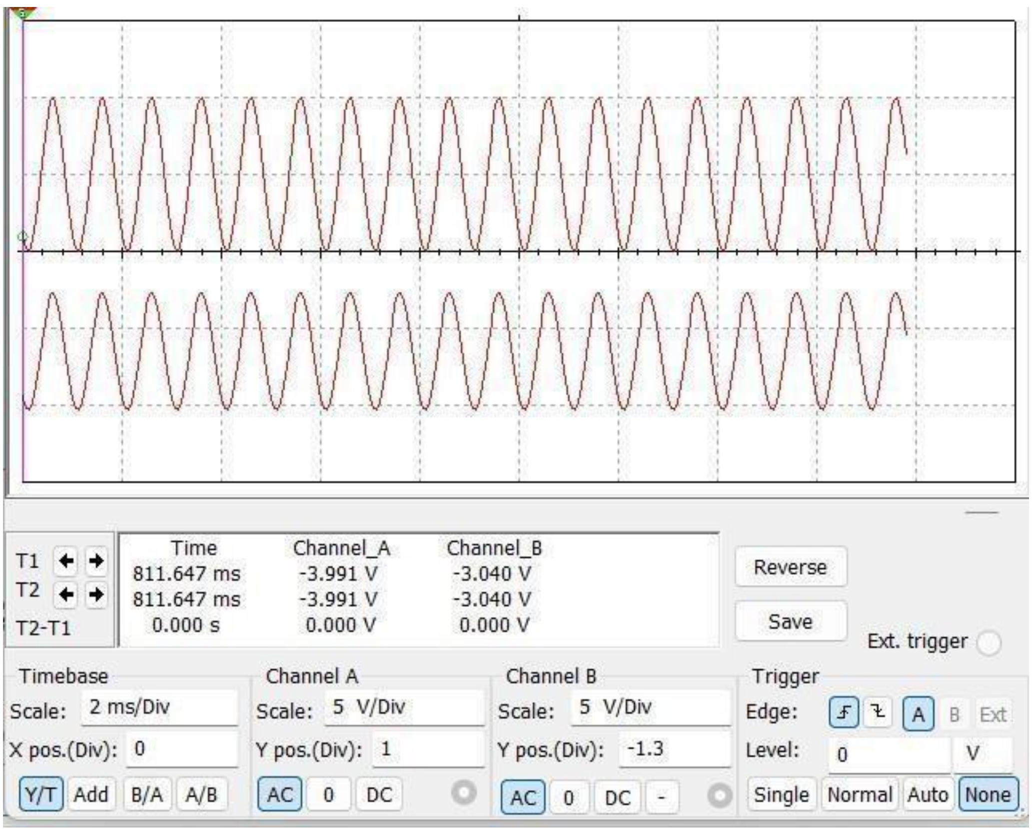
From the maximum power transfer theorem we can conclude that the voltage is divided equally if the a test resistance when kept in series with AC signal source is equal to the input resistance.
For that we need to try different combinations of test resistance(R_s). For which the voltage divides equally is the input resistance.


XSC2
XSC3
VCC
12V
R1
18.3kΩ
Q1
R7
10kΩ
C1
10µF
V1
5Vpk
1kHz
0°
R2
22kΩ
C2
10µF
R3
2.4kΩ


T1
T2
T2-T1
Time
Channel_A
Channel_B
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 1
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): -1.5
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None
T1
T2
T2-T1
Time
Channel_A
Channel_B
Reverse
Save
Ext. trigger
Timebase
Scale: 2 ms/Div
X pos.(Div): 0
Y/T Add B/A A/B
Channel A
Scale: 5 V/Div
Y pos.(Div): 1.5
AC 0 DC
Channel B
Scale: 5 V/Div
Y pos.(Div): -1
AC 0 DC -
Trigger
Edge:
A B Ext
Level: 0 V
Single Normal Auto None

Case 1: R_S=3k Ω

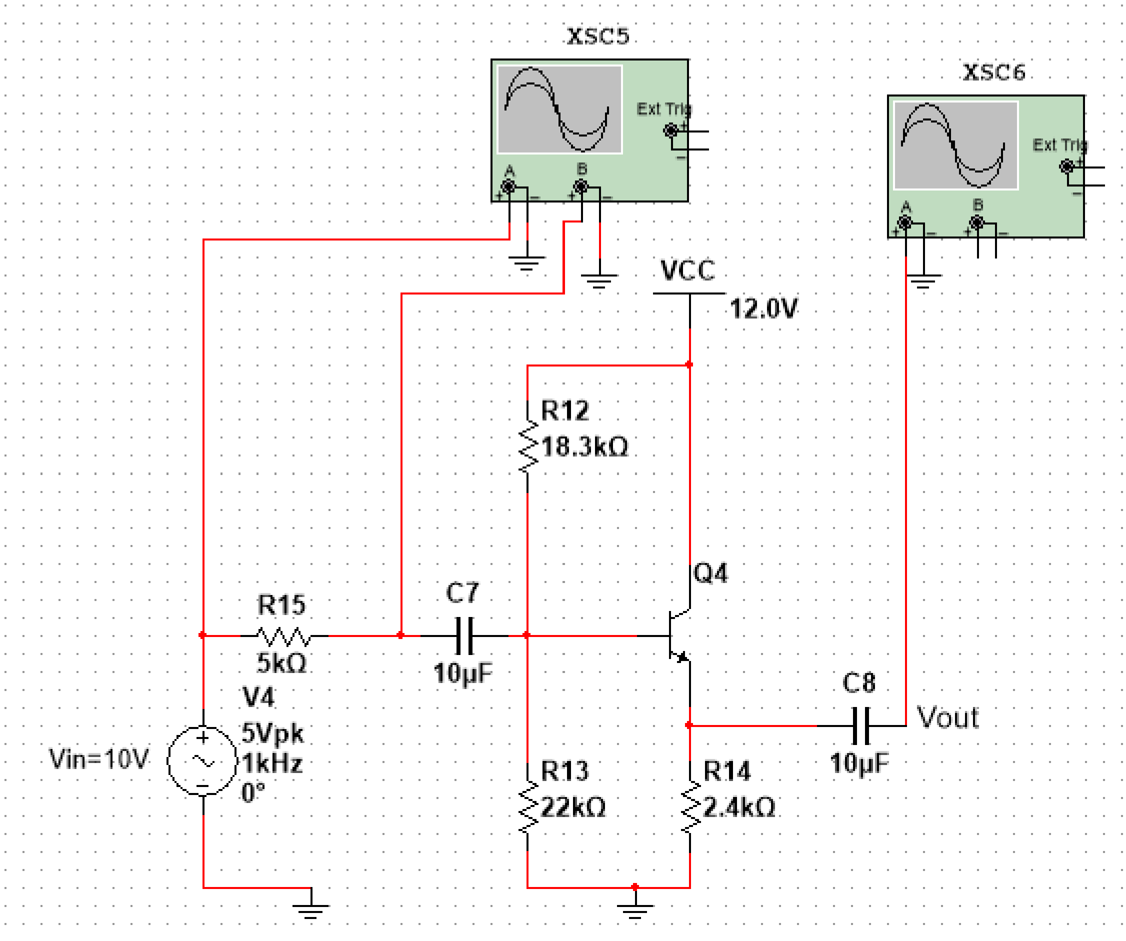


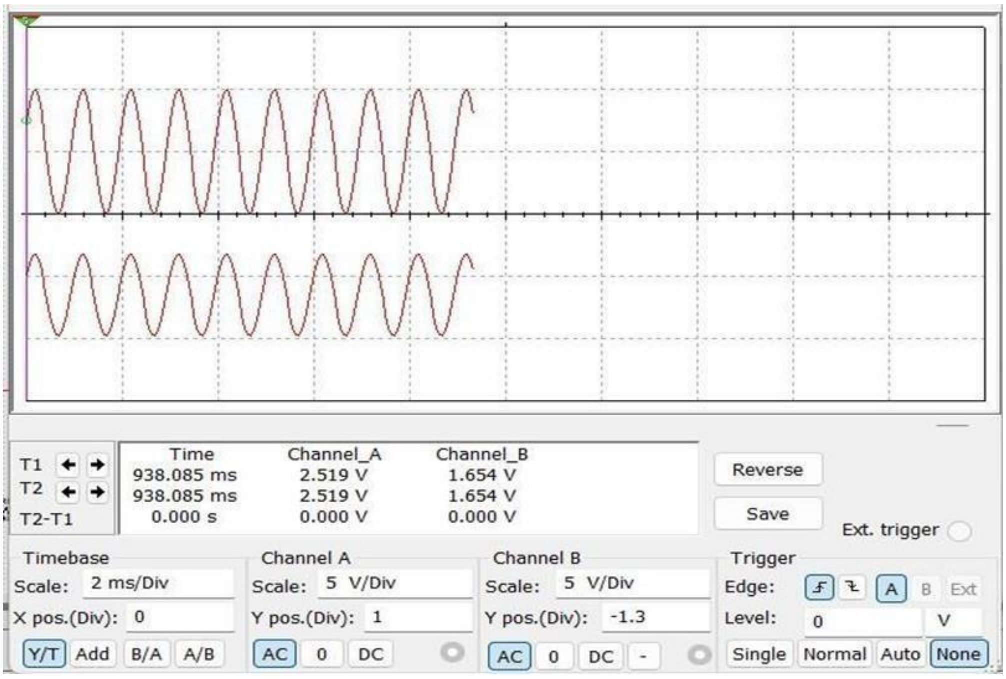


Input Voltage(V_i)=10V

Voltage after drop across test resistance((V_{is}) ~=8.5V

Case 2: R_s=5k Ω

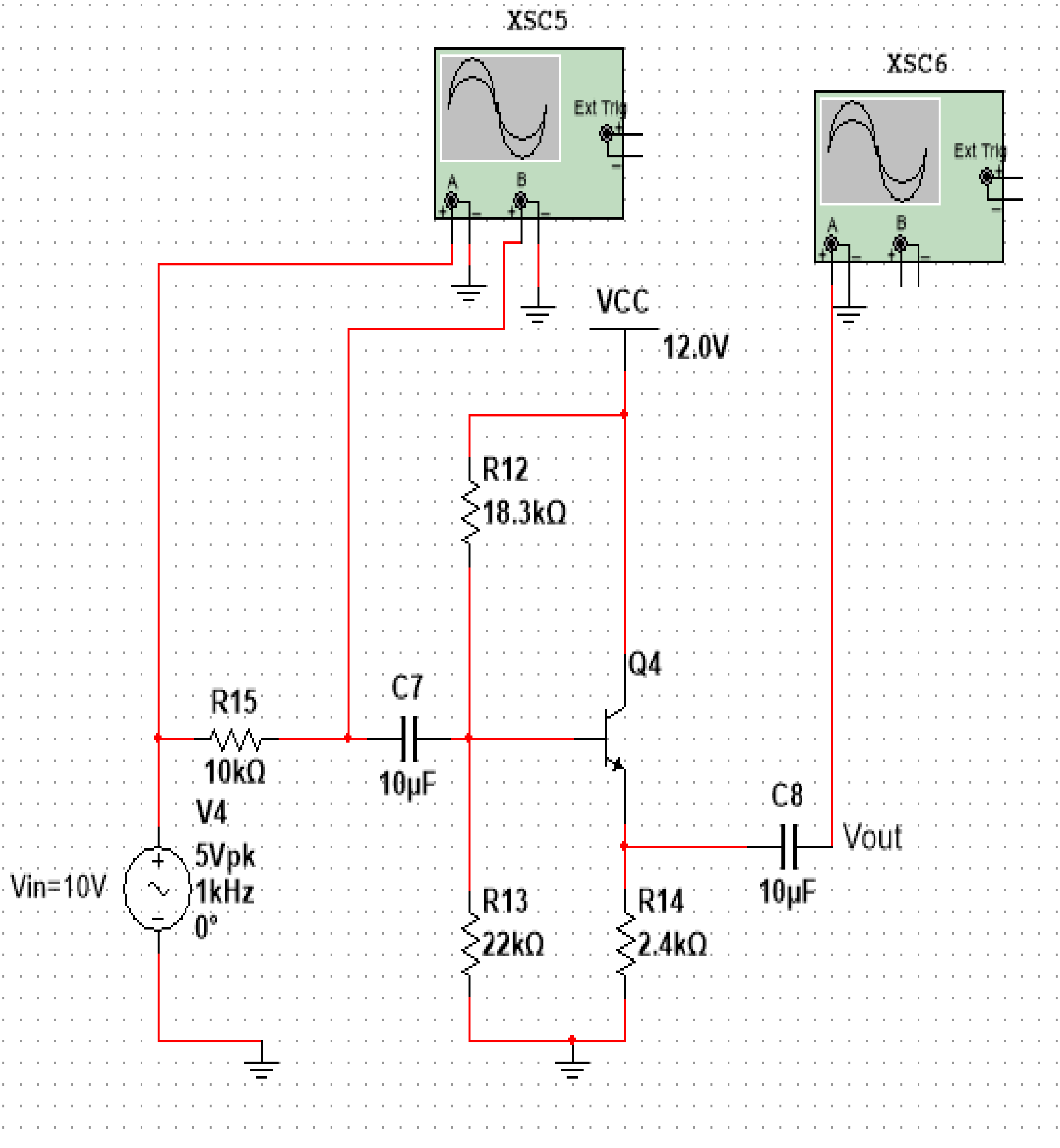




- Input Voltage(V_i)=10V

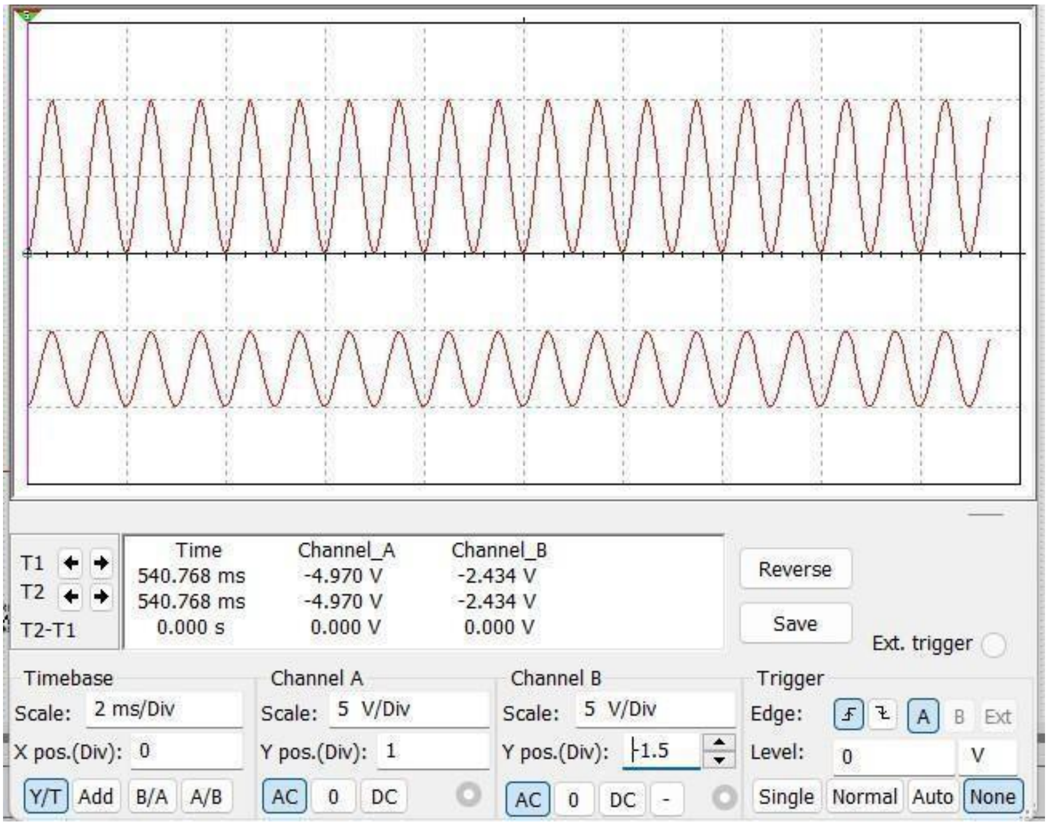
- Voltage after drop across test resistance(V_{is}) ~=7V

Case 3: R_s=10kΩ



- Input Voltage(V_i)=10V

- Voltage after drop across test resistance(V_{is}) ~=5V



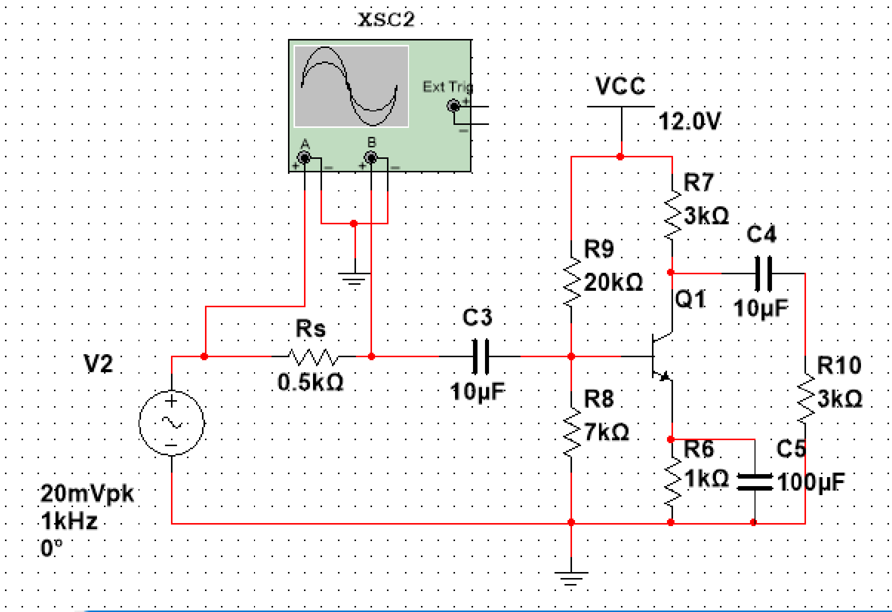
Conclusion:
For the given circuit the voltage gets divides exactly in half for R_s~=10KΩ. From the maximum power transfer theorem we can say that the input resistance is about 10kΩ. R_{in}=10KΩ.

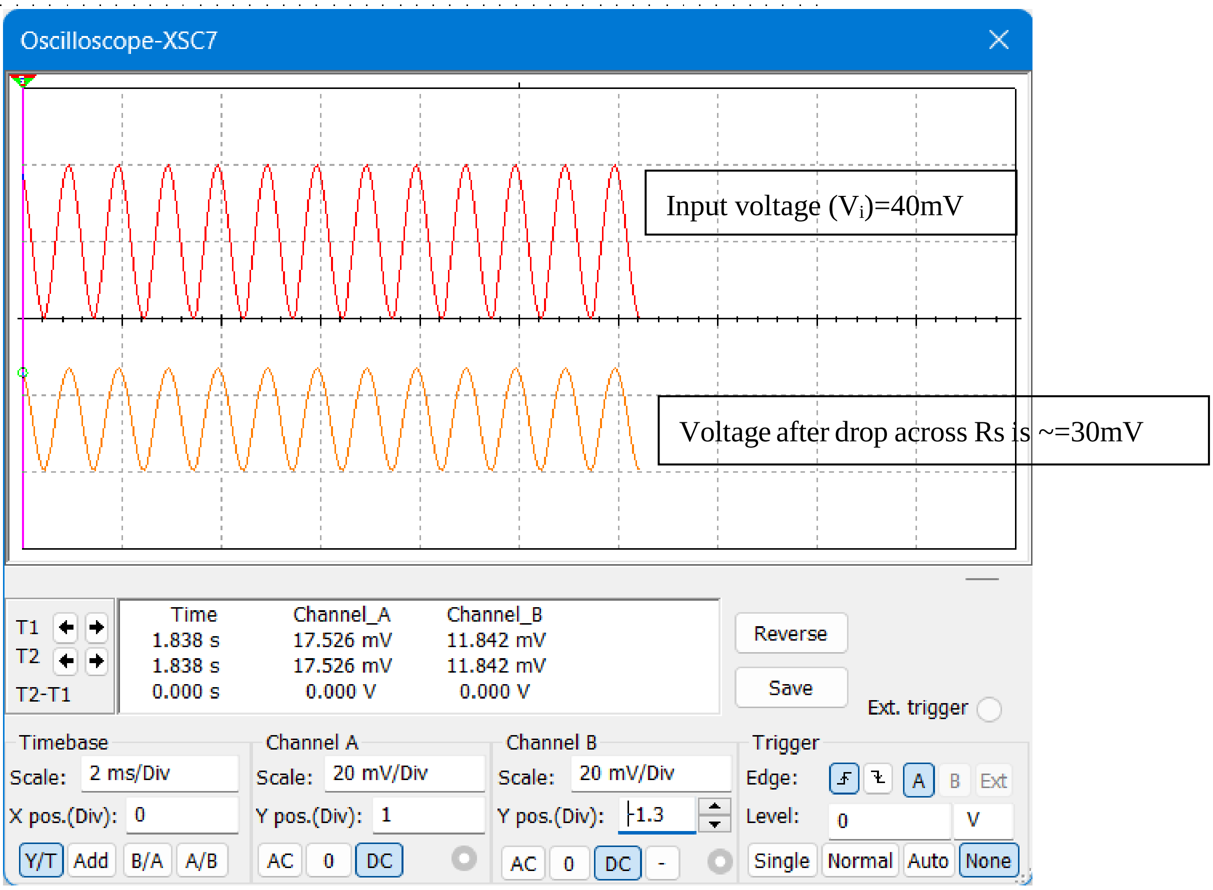
Calculation of input resistance for CE amplifier through maximum power transfer theorem:

Rs = 20kΩ||7kΩ||1kΩ
= 5.18kΩ||1kΩ
= 0.83kΩ

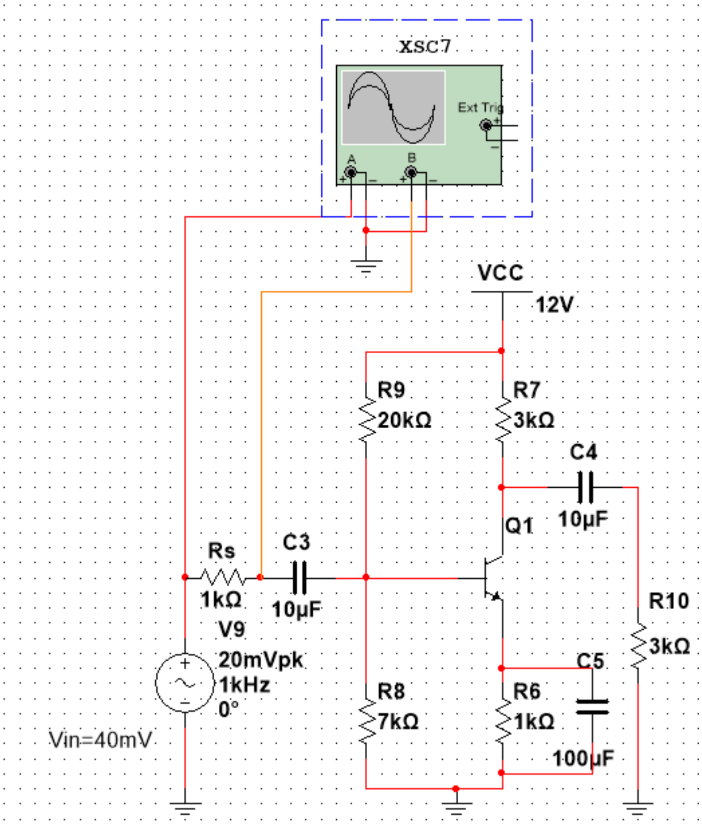
$\boxed{\text{Rs~=870Ω ~=1kΩ(Practical)}}$

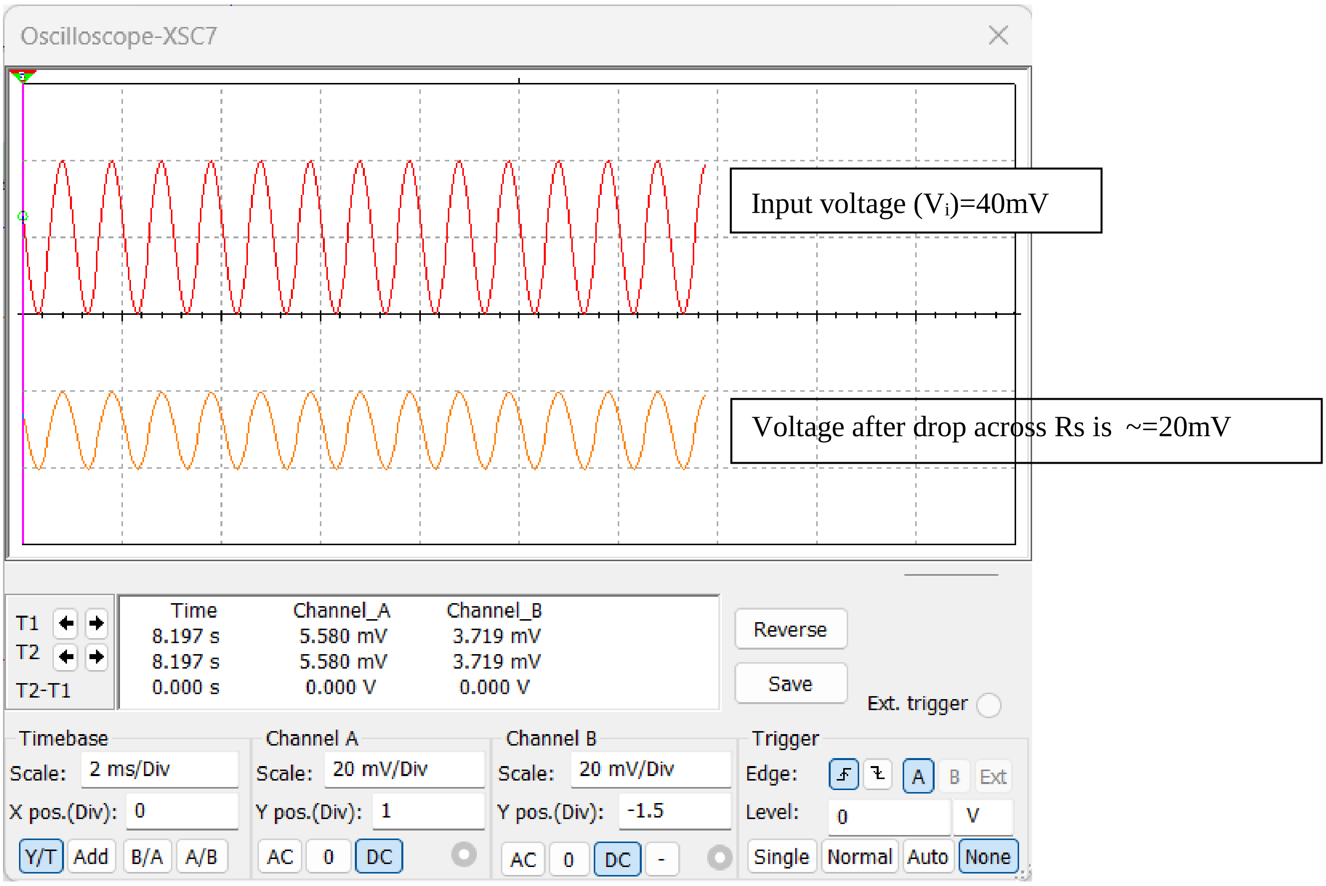
Case 1: R_s=0.5kΩ





Case 2: R_S=1kΩ

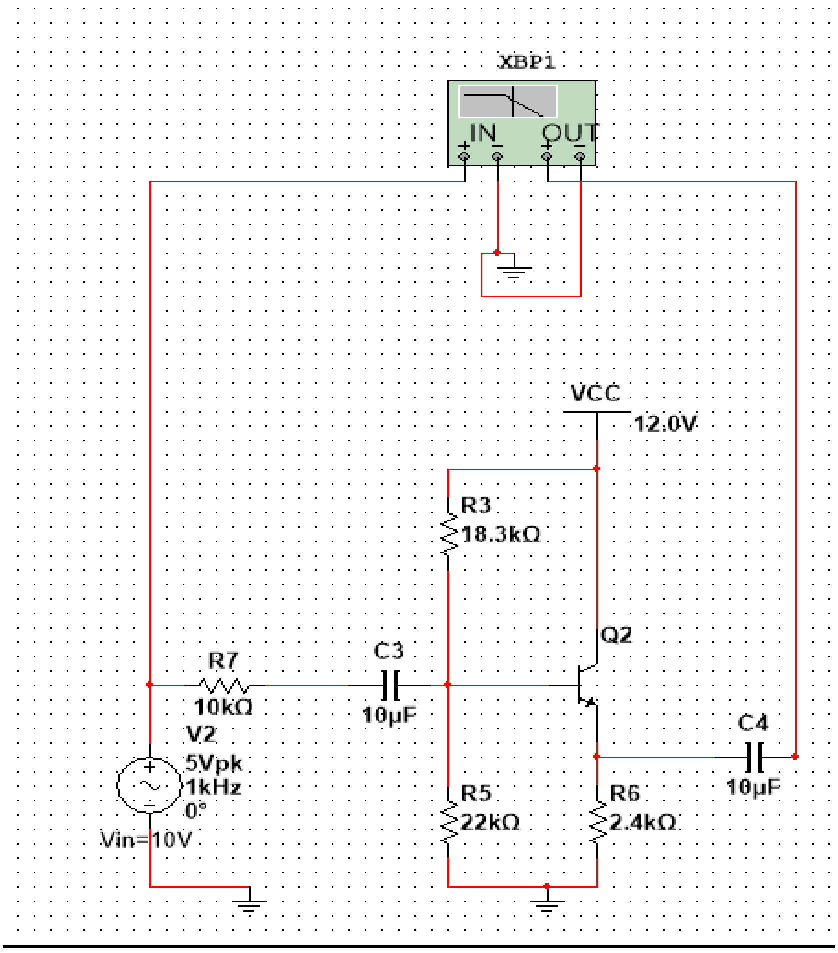


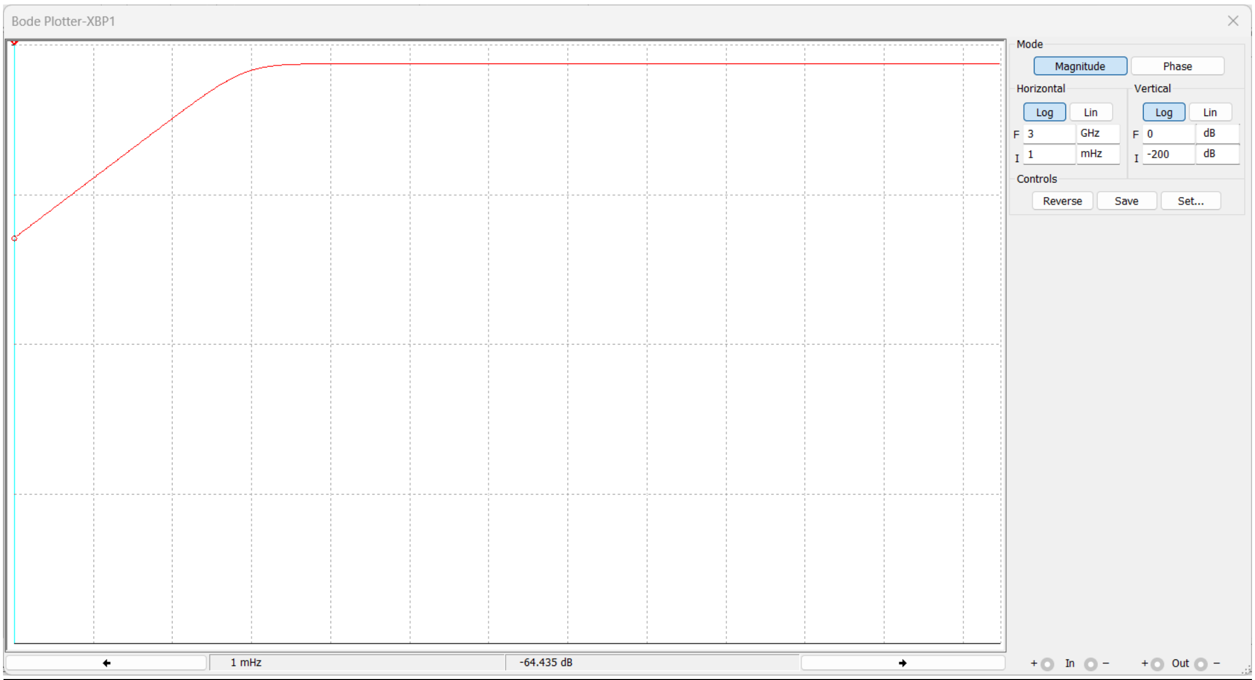


Conclusion:

For the given circuit the voltage gets divides exactly in half for Rs~=1KΩ. From the maximum power transfer theorem we can say that the input resistance is about 1kΩ.

Frequency Response of CC Amplifier:





Hardware Simulation:

Procedure:

1. Connect the circuit as per the circuit diagram.

2. Apply the Vcc=12V.

3. To calculate the input resistance of the transistor, connect a variable resistance box in the place of the 10KΩ resistor from the above diagram.

4. Connect voltmeters at the input and beside the variable resistor box.

5. Now vary the resistance in such a way that the Voltage in the second voltmeter should be half of the voltage in the first voltmeter so that maximum power transfer would take place.

6. The resistance value at which the voltage will be divided equally is the value of the Input Resistance of the Transistor Circuit.

Frequency(hertz)	Input Voltage(volts)	Output Voltage(volts)	Gain
500	**7.6**	7.6	1
1k	7.6	7.6	1
15k	7.6	7.6	1
20k	7.6	7.6	1
30k	7.06	7.07	1.01
40k	7.06	7.07	1.01
50k	7.6	7.6	1
60k	7.6	7.6	1
70k	7.6	7.6	1
80k	7.6	7.6	1
100k	7.6	7.6	1
1M	7.6	7.6	1
2M	7.6	7.6	1
3M	7.6	7.6	1

Conclusion:

For cc amplifier, the voltage gain is almost equal to one in all the frequency regions.

Result:

CC Amplifier	design	software	hardware
Gain	1	1	1
Input resistance (ohm)	10k	10k	10k